

# **New USGS Estimates of Undiscovered Oil and Gas Resources for the World**

*By Thomas S. Ahlbrandt and Gene Whitney\**

## **Abstract**

Worldwide supply of oil and gas is ultimately linked to the geologic abundance and distribution of those fossil fuels. The U.S. Geological Survey is completing a new assessment of the technically recoverable undiscovered oil and gas resources of the world. Nearly 1,000 provinces were defined and known petroleum resources exist in 406 of these. A total of 76 priority provinces, containing over 95% of the world's known oil and gas, and 52 "boutique", or highly prospective, provinces are being assessed. Based upon our initial analyses, several observations are clear. First, our estimates of total undiscovered technically recoverable petroleum (oil, natural gas, natural gas liquids) resources will probably not differ greatly (+9.5%) from the world totals determined in the 1994 USGS world assessment. However, our estimates of undiscovered oil are up considerably (+24%), and their regional distribution differs significantly from previous estimates. Secondly, estimates of global undiscovered natural gas resources are smaller than previously estimated (-10.4%) largely due to decreases in the Former Soviet Union, and natural gas liquids resources are significantly larger than previous estimates because co-product ratio calculations were included in this assessment. In addition, field growth mean estimates of known oil and gas fields will likely equal quantities of undiscovered resources and are a critical component of any analysis of world oil and gas supply.

## **Introduction**

The U.S. Geological Survey has conducted a series of assessments of undiscovered resources for both the U.S. and for the world. These assessments provide a snapshot of current information about the location and abundance of oil and gas resources at a point in history. Such an overview provides explorationists, economists, and investors a general picture of where oil and gas resources are likely to be developed in the near future.

The most recent previous world assessment of oil and gas was completed in 1993 (Masters and others, 1994, 1997). In that assessment, total undiscovered oil resources for the world were estimated to be 582.6 billion barrels (mean), and the total endowment of oil for the world was estimated to be 2,272.5 billion barrels (mode). Masters and others (1994, 1997) estimated that a total of 5,791.0 trillion cubic feet (tcf) of natural gas remained undiscovered (mean value), and they estimated the total endowment of natural gas to be 11,567.6 tcf (mode). Those estimates were determined using a modified Delphi process (Masters and others, 1994).

In 1995, the U.S. Geological Survey initiated a new geologic assessment of the world's oil and gas resources in response to the rapidly changing landscape of world petroleum supply. The political and economic framework in which oil and gas are produced, marketed, and consumed has

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evolved rapidly over the last few years. Changes have also been swift and significant in exploration technology, onshore and offshore production technology, and the quantity and quality of geologic and geophysical data available. The geography of exploration and production have also changed significantly, especially in response to new developments in offshore drilling and production technology. These rapid changes have generated both the need for and the ability to conduct a new global assessment of undiscovered oil and gas resources. The purpose of this paper is to summarize the results of the new USGS 2000 World Energy Assessment in the context of world energy supply.

## **Assessment Strategy And Methodology**

In the current world oil and gas assessment, we divided the world into approximately a thousand provinces, based primarily on geologic factors, and these provinces were grouped into the eight regions roughly comparable to the eight economic regions defined by the U.S. State Department. A team of geologists was assigned to each of the eight regions to compile and interpret existing geologic information for evaluation of the oil and gas potential within each region and its provinces. Total petroleum systems and their subdivisions (assessment units) were defined in these provinces and are the basic unit of assessment used in our current assessment.

Significant petroleum resources are known to exist in 406 of the 1000 geologic provinces. By allocating historical production for approximately 32,000 oil and gas fields to the world's provinces, we were able to identify 76 provinces that account for over 95% of the world's known oil and gas. These 76 provinces were established as the highest priority provinces for detailed examination in this assessment. However, past production and discovery does not necessarily provide a rigorous indicator of future discoveries, so an additional 52 "boutique", or highly prospective, provinces were also selected for detailed examination and assessment, bringing the total number of provinces evaluated to 128, located in 96 countries and 2 jointly-held areas. An additional 17 assessment units were identified in which significant unconventional resources such as coalbed methane, basin-centered gas, gas hydrates, and heavy oil occur, but these were not assessed.

USGS geologists compiled data on each of these provinces to provide a scientifically defensible estimate of undiscovered oil and gas resources in each province. For each of the 128 assessed provinces, geologists defined total petroleum systems, which consist of all genetically related petroleum generated by a pod or closely related pods of mature source rocks (Schmoker and Klett, 1999). A total of 159 total petroleum systems were evaluated. Each total petroleum system was subdivided into assessment units that represent mappable volumes of rock within the total petroleum system that could be assessed. Approximately 246 assessment units were examined in detail. In each assessment unit, quantities of undiscovered conventional oil, gas, and natural-gas liquids were estimated that may potentially be added to reserves within the next thirty years (1995-2025). Thus, this assessment of the world's undiscovered oil and gas resources provides a geologic foundation of unprecedented detail in support of the resource estimates assigned to each assessment unit, total petroleum system, and allocated to provinces, regions, and onshore/offshore areas. All of the geologic

characteristics are captured digitally in maps and databases, and these products will be published along with the final assessment numbers in a U.S. Geological Survey Digital Data Series #60 CD-ROM. Resource estimates are regularly revised during subsequent assessments, and we expect that the current results will be revised in the future as well. However, the detailed information we provide to support these assessment numbers allows the incremental incorporation of new data as they become available for each assessment unit and will allow for interim adjustment of resource estimates on a continual basis.

The numbers reported here are for conventional hydrocarbon resources only, and do not include unconventional oil and gas resources such as tar sands, heavy oil, or gas hydrates.

### Results

Our estimates for undiscovered conventional oil, natural gas, and natural gas liquids are shown in Table 1 with assessed values from the USGS 1993 World Assessment (Masters, 1994). Our estimates for undiscovered oil have increased 24.3% over the 1993 World Assessment numbers, whereas natural gas is estimated to be 10.4% less than the previous assessment. Undiscovered natural gas liquids are 104% above the previous estimates. The total for undiscovered oil, natural gas, and natural gas liquids shows a modest 9.5% increase over the 1993 estimate for the world.

**Table 1**  
**Volumes of Undiscovered World Petroleum, by Commodity, from this Assessment (mean values, including the United States<sup>1</sup>)**

	<b>USGS 2000 Assessment (this study)</b>	<b>USGS 1993 Assessment (Masters, 1994)</b>
Undiscovered oil	724.2 billion barrels	582.6 billion barrels
Undiscovered nat. gas	5245.6 trillion cu. ft.	5791.0 trillion cu. ft.
Undiscovered natural gas liquids	209.1 BBOE <sup>2</sup>	102.2 BBOE
World Total	1807.6 BBOE	1650.1 BBOE

<sup>1</sup>U.S. values taken from the U.G. Geological Survey 1995 National Assessment

<sup>2</sup>BBOE = billion barrels of oil equivalent.

In addition to estimates of the undiscovered volumes of oil, natural gas, and natural gas liquids, we have also made an estimate for reserve growth (also known as field growth) for the world (Table 2). The phenomenon of reserve growth, in which original reserves estimates increase over time as exploration and production technologies and strategies improve, accounts for a significant amount of petroleum not currently accounted for under known reserves or undiscovered resources. In fact, the contribution of reserve growth to the world's oil endowment is only slightly less than then contribution from undiscovered oil (mean values). Likewise, reserve growth for natural gas is estimated to be about 63% of the undiscovered natural gas resources (mean values). Of course, there is significant uncertainty associated with reserve growth estimates because of uncertainties about future advances in exploration and production technology and uncertainty about prices. However, we feel that reserve growth has played a significant role in the increase in reserves in the past and will continue to be important, and perhaps increase in importance, in the future.

**Table 2**  
**Estimates of Reserve Growth for Various Petroleum Commodities for the World (exclusive of the United States)**

Oil reserve growth	612 billion barrels
Natural gas reserve growth	3,305 trillion cubic feet
Natural gas liquids reserve growth	42 BBOE

The regional distribution of undiscovered resources is shown in Table 3. Although the relative abundance of oil and gas resources among the regions of the world is consistent with past estimates, we conclude in the current assessment that the Former Soviet Union and Asia contain significantly less natural gas than previously estimated, that the deep water resources in the South Atlantic and Middle East account for significant increases in undiscovered oil, and that North American (Canada and Mexico) resources of oil and gas are somewhat less than previously estimated.

**Table 3**  
**Volumes of Undiscovered Oil and Undiscovered Natural Gas by Region, Including Percentages of World Totals (mean values, exclusive of the United States)**

<b>Region</b>	<b>Undiscovered Oil (billion barrels)</b>	<b>Percent World Total</b>	<b>Undiscovered Gas (trillion cubic ft.)</b>	<b>Percent of World Total</b>
<b>1:</b> Former Soviet Union	116	17.9%	1611	34.5%
<b>2:</b> Middle East and North Africa	230	35.4%	1370	29.3%
<b>3:</b> Asia-Pacific	30	4.6%	379	8.1%
<b>4:</b> Europe	22	3.4%	312	6.7%
<b>5:</b> North America*	70	10.9%	154	3.3%
<b>6:</b> Central and South America	105	16.2%	487	10.4%
<b>7:</b> Sub-Saharan Africa and Antarctica	72	11.0%	235	5.0%
<b>8:</b> South Asia	4	0.6%	120	2.6%
<b>World totals*</b>	<b>649</b>		<b>4669</b>	

\* Exclusive of the United States

### Implications

Despite speculation that the industrialized world must move away from reliance on fossil fuels, it remains likely that demand for oil and natural gas will remain strong for at least a few more decades. According to our estimates, 75% of the world's oil endowment is now known but only about 24% of that endowment has been produced so far. Likewise, approximately 66% of the world's endowment of natural gas is now known, but only about 11% of the world's total natural gas has been produced so far. Of course, these numbers cannot be used to calculate a simple projection of petroleum depletion for the world, but the numbers suggest that hydrocarbons are not yet scarce on a global scale, but their location is largely known (25% of total oil endowment remains undiscovered and 33% of the world's total endowment of natural gas remains undiscovered).

The total global endowment of hydrocarbons is likely to be less important in determining future supply than the regional distribution of those resources. The fact that 35.4% of the world's undiscovered oil resources and 29.3% of the

(continued on page 31)

## **Perspectives on the Brazilian Petroleum and Natural Gas Industry in the 2000 to 2020 Period: The Results of a National Survey**

*Edmilson Moutinho dos Santos\**

### **Introduction**

The coming of a new millenium almost coincides with the opening of Brazil to international oil and gas investors. It is, therefore, interesting to analyze the market perception regarding the perspectives for the Brazilian petroleum and natural gas industry to face the challenges of the next millenium. This work presents the results of a survey undertaken by the University of São Paulo, Brazil, from December 1999 to February 2000. We asked several participants on an email list, including different representatives from the government, academia, people from the oil industry, bankers and lawyers, about their perspectives for Brazil in the oil and natural gas world during the 2000 to 2020 period. After reviewing the methodology adopted in the survey, we summarize the results without identifying the individual answers, but trying to express the contradictions found among the different opinions as well as identifying the topics for which certainties do not exist. We conclude by underlining what we believe to have been the most important results of this survey.

### **Presenting the Questionnaire and the Methodology**

The questionnaire was composed of the following questions:

- Question 1: What will the role of oil and gas in Brazil be during the period 2000 to 2020?
- Question 2: Which are the most important factors that will mark the evolution of the oil and natural gas industry in Brazil during the period 2000 to 2020?
- Question 3: How do you see the future evolution of international oil prices in the 2000 to 2020 period?
- Question 4: How will the competition develop in the Brazilian petroleum and natural gas industry during the period 2000 to 2020?
- Question 5: Will Brazil be competitive in the following areas: E&P Offshore? E&P Onshore? Downstream activities? And Natural gas?

The questions were sent by email to participants of a list called Oil Forum, which is also a University of São Paulo's initiative, bringing together different representatives from the Brazilian oil and gas industry, government, academia, bankers and lawyers. The participants were invited to contribute to the survey knowing that only the aggregate result of answers would be published. The questionnaire was sent at the end of December 1999, with the answers being received, also by email, from January to February 2000. In the next section, we summarize the results, trying to express the contradictions between the different opinions as well as

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identifying the topics for which certainties may not prevail.

### **Brazil's Perspective in the Oil and Natural Gas Business in the Period 2000 to 2020**

For most participants in the survey, oil and natural gas will continue to be the world's main primary energy during the period 2000 to 2020. This twenty years period is considered too short for major changes in the global energy mix, with the development of any alternative energy that can provide the same cost/benefit relation in terms of energy quantity per volume per monetary unit as oil and gas do. Therefore, alternative renewable energies such as biomass, solar and wind will remain restricted to niche markets, finding it difficult to reach big energy consumers which demand large amounts of reliable energy. Hydrogen is believed to continue rising as a competitive energy source, being likely fully available by the middle of the new century. Meanwhile, it will increase its share in the transportation sector. However, over the 2000 to 2020 period, hydrogen, as well as electricity, will only be competitive for specific passenger vehicles and in smaller cities.

In the developed world, most responders believe that oil and gas will see their economic importance and political influence decline as the richest countries speed up their entrance into the New Economy, based mainly on information and communication. The amount of energy consumed per dollar of GDP created will keep falling in the United States as well as in Japan and West Europe. Total oil and gas demand in those countries will likely increase, but only marginally as compared with their economic growth.

As far as Brazil is concerned, most responders believe the country will see an increasing role for natural gas in the national energy matrix while the dependence on imported oil will likely decline over the 2000 to 2020 period. As the country opens up its upstream sector for private investors, it will boost national oil and gas production. Taking oil and gas together, Brazil, as other less developed countries, might become even more dependent on fossil fuels as natural gas strengthens its role in electricity generation, diminishing the relative share of hydropower generation. Since the country is making only minor efforts in developing alternative energies, most responders believe Brazil will keep its high dependence on hydrocarbon until the middle of the century.

By 2050, the country might actually start increasing its dependence on imported oil and natural gas again, as national production may no longer keep pace with the growth in national energy demand. This perspective can significantly change if the country restarts investing massively in new energy technologies. Brazil's perspectives for renewable energies such as solar, hydro and biomass are considered high, with fast prospect for market insertion.

The survey presents the evolution of the international oil prices as the most important variable that will determine how the international and national oil and gas business will evolve during the 2000 and 2020 period. If anything, the only certainty among the answers is the uncertainty about the future evolution of the oil prices. From those that believe a broad price stability at approximately 20 US\$/barrel (at current dollar) will prevail over the next 20 years and those expecting continuing instabilities, with prices oscillating from 10 to 30 US\$/barrel, we find no common ground. Some responders see oil prices declining to 10 US\$/barrel or less, following productivity gains and cost reductions; others

foresee a rising curve with prices growing with more or less oscillation up to a sustainable 30 US\$/barrel by the year 2020, reflecting oil and gas scarcity. However, within the range of 15 to 30 US\$/barrel, most responders believe that international oil prices will cause no significant shift in the trends and competitive forces that are already in place in the international oil business.

With the end of the former national monopoly, and as long as newcomers start investing in the country and more transparency is achieved in the management of the Brazilian national oil company, Petrobras, and in the definition of the national oil policy and regulation, Brazil will be much more influenced by international oil prices. According to most opinions, Brazil, in terms of upstream activities, must be seen as an important alternative Non-OPEC country. The country's competitiveness depends on the behavior of international oil prices whose collapse to 10 US\$/barrel or less may undermine Brazil's position in the global upstream business. With prices oscillating within the 15 to 30 US\$/barrel range, Brazil is competitive and can attract upstream investors. In downstream activities and with natural gas, Brazil's competitiveness is primarily founded on its internal market, with a high propensity to grow faster than the world average.

The opening up of the former national monopoly and the development of new technologies, especially for deep-water offshore activities, will certainly be the two major driving-forces in the Brazilian upstream industry. In addition, new business and technological approaches are expected to appear and increase the competitiveness of Brazilian onshore activities, which might be especially attractive for small-and-middle-sized oil companies. In the downstream sector, the entrance of new players and the full opening of the market for oil product imports are also expected in the 2000 to 2020 period. The major challenges for Brazilian refineries are seen as the need of strong cost reductions and the improvement of both refined product quality and of operations to comply with more stringent environmental and safety regulation. In addition, as natural gas is expected to substitute for fuel oil in important industrial markets, major investments will be needed in refining upgrading units.

For natural gas, the national consumption is expected to increase quite steeply. In power generation, natural gas will favorably compete with hydropower and other energy sources such as biomass, fuel oil, nuclear and coal. Nevertheless, in the shorter term, many barriers such as price and market uncertainties must still be removed. Other final consumers will also gradually perceive the advantages of natural gas, raising their acceptance of this energy source. However, more sophisticated gas markets will only develop if heavy investments take place in building up the transportation and distribution infrastructures.

Regarding the future competition scenario within the country, the most obscure factor is whether or not (and when and how) the Brazilian national oil company, Petrobras, will be privatized in the 2000 to 2020 period. Several responders do not expect Petrobras' full privatization over this 20 years period, believing the company still has a role as a state-owned enterprise that will allow the government to go through a long transition period towards a more competitive market. Some answers point out Petrobras' privatization as essential condition to construct this competitive market. In addition, some responders are convinced that the state-company will only be

competitive if detached from its current governmental budgetary constraints. Regardless of its status, Petrobras will nevertheless have to compete with other players both in the upstream and downstream sector as well as in the natural gas segment.

As far as the upstream is concerned, most answers suggest that the Brazilian geological and technological competitiveness is already proved in offshore activities and particularly in the deep-water offshore areas. Onshore prospects are still seen by most participants as something with low geological competitiveness and low attractiveness for larger international oil companies and for the introduction of necessary new technologies. Some responders believe, on the other hand, that Brazil will hardly experience a major upstream boom during the 2000 to 2020 period. Brazil is still perceived as a country with high political and economic risk. Macroeconomic stability is far from being accomplished and oil is seeing by the government as a "cash cow" (government take on high-prospect offshore activities is high; there is no incentive for low-prospect offshore and onshore investments; indirect taxation is confusing and with important impacts on upstream projects). Furthermore, social pressures arise everywhere in the domestic political scene and may eventually shift the current political color, pro-foreign direct investments, towards more nationalistic movements, scaring potential oil investors. According to those opinions, Brazil will stand as just a minor Non-OPEC player in the global upstream business.

Despite any further extensive consideration, most responders believe Brazilian domestic upstream competition can still deepen over the next 20 years period, although Petrobras is unlikely to lose its leadership and ability to orchestrate domestic competition. By entering into partnerships with private investors, Petrobras will be required to develop more transparency and a more commercial behavior. The national company will also have to compete with other players to acquire new exploration and production areas in the country through the bidding processes organized by the National Petroleum Agency (ANP). From 2001 and on, the company will start relinquishing some of its current exploration areas, opening new opportunities for ANP to grant those areas to new investors. On the other hand, as Petrobras starts its plan to restructure its upstream asset portfolio, giving up some E&P areas, there might be more room for the birth of other small-and-middle-sized private oil firms. In spite of all those expected evolvments, the domestic upstream competition in Brazil will remain healthy over the whole 2000 to 2020 period. According to most responders, competition may only become fierce if international oil prices decline towards the 10 US\$/barrel level and/or when larger-and-with-more-impact projects become scarcer in the country (possibly not before 2020).

For downstream activities, the competition issue is believed much more complex and the survey hardly found a dominant opinion. As far as the economic scale and the growth potential are considered, Brazil is certainly seen as a competitive market with strong attractiveness for potential investors in new refining, distribution and marketing activities. However, in an open market environment, domestic production will have to compete with imported refined

*(continued on page 28)*

## **Perspectives on Brazil** *(continued from page 27)*

products coming from Argentina, the Mediterranean region, the U.S. Gulf Coast and/or from Venezuela and the Caribbean area. As believed by some responders, in the short and middle term, maybe up to 2005, the availability of idle capacity in those exporting regions may diminish the interest of building new refineries in Brazil. Competition will take place only between domestic and imported products, with an important location advantage for national refiners. As long as Petrobras keeps its almost full monopoly on the Brazilian refining industry, competition will be restricted, and the national oil company will alone enjoy this geographic advantage. The strategy to speed up competition in the Brazilian downstream sector divides the survey's responders into two groups. The first group believes the partial privatization of Petrobras' refineries will speed up the entrance of newcomers and, therefore, the competition in the Brazilian refining sector. Petrobras should speed up downstream investments abroad offsetting losses of market share domestically. The second group holds that this strategy violates the current global concentration trend, compromising the Brazilian national oil company's ability to compete globally with other mega-players. Among those supporters, some responders believe the government would underrate Petrobras' value by splitting up its downstream assets rather than privatizing the company as a block.

The answers have also highlighted some future perspectives for the distribution and marketing sectors. Again, no common ground is found. On one hand, some responders suggest the continuous strengthening of small-and-very-small companies, playing a strong focus strategy and conquering the loyalty of local consumers through personal attention and a long-term relationship, will gradually reduce the power of big distributors and marketers. On the other hand, we find answers pointing out concentration as the major driving force. The development of small players is seen as a transitory phenomenon. The most successful small players will end up on the hands of a big company. Acquiring such companies might be the easiest strategy for entry into the Brazilian market. Small companies will be restricted to insignificant niche markets. The only common opinion among most responders is the general view that distribution and marketing margins might decline over the 2000 to 2020 period.

As far as natural gas is concerned, the current infant industry has an enormous growth potential. Petrobras as well as many international and national private companies look for the best opportunities to position themselves in this new market. In the first step, the most prominent gas distribution companies have been privatized and distribution monopolies were transferred to private agents. High-pressure transportation infrastructures are still in Petrobras' hands, through its gas branch, Gaspetro, although Gaspetro shares its most important asset, the Bolivia-Brazil gas pipeline, with other international private actors through the company called TBG. From an optimistic scenario, where the market was expected to grow steeply, mainly through gas-fired power stations, the industry dived into a structural impasse with many price and market uncertainties slowing down investment decisions. As agreed by most responders, over the 2000 to 2020 period, competition will probably be almost absent in the construc-

tion of the Brazilian natural gas industry. Regional private monopolies will dominate gas distribution. Petrobras will keep a large majority share in gas transportation and production. The government will take the whole risk on gas-fired power generation, securing private investors from commercial and financial risks.

### **Conclusion**

This survey clearly shows that, according to Brazilian experts, the oil and natural gas industry is expected to decline in importance as a leading business in the more developed world. Gradually, other sectors such as the information and telecommunication industries will surpass the oil and natural gas sector in terms of economic and political power. However, oil and gas will still be the world main primary energy, fueling global economic development during the period 2000 to 2020. In Brazil, the economic context is different and the energy sector, and particularly the oil and gas industry, will continue being the nation's greatest business. Oil and gas will still hold strong economic and political influence, fueling national economic growth, attracting private investment and creating the necessary energy basis for Brazil to also enter the new information and communication economy. The market perceives those two different realities when it analyzes Brazilian potential in the global and natural gas industry.

Another important conclusion from this survey suggests that Brazil seems reasonably competitive in oil and gas activities, particularly if international oil prices move within a 15 to 30 US\$/barrel. This price scenario is convincing. That is why Brazilian specialists fairly believe the country will maintain its competitiveness to attract investments, although a very big and sustainable oil and gas boom is more questionable over the considered 20 year period. Therefore, although optimistic, the market seems cautious in forecasting the future. Moreover, the market recognizes major uncertainties and their potential impacts on the evolution of the national industry. Realism seems less present regarding the natural gas sector. Here, given the absence of tradition and the infancy of the industry, the market seems much more confident of a brilliant future despite important obstacles that are still in place slowing industry development.

Also essential to mention is that the survey's results show a discerning view of the market, dismissing traditional Brazilian nationalistic feelings, which used to indicate some market immaturity. According to the responses presented in this survey, the specialists are aware of Brazil's potential and difficulties as well as of the country's competitive advantages and disadvantages in the oil and the natural gas business. The general understanding is that Brazil is still far on the road of defining and establishing adequate and pro-active actions that can transform the country into a really attractive zone for oil and gas investments. Yet the general belief is that the new institutional order will be more successful in screening out and selecting those actions. Finally, the survey concludes that, over the 2000 to 2020 period, the time may turn out to be too short for creating strong competition in the Brazilian oil and gas market, diminishing the influence of the country's former state-controlled monopolies. However, the opening up process will continue advancing, gradually changing the competition environment.

## Sweating Through Hot Summer In California

By Fereidoon P. Sioshansi\*

Wednesday, 14 June, was an unusually hot day in Northern California. New temperature records were set in San Francisco and beyond. As previously reported, there was not enough generation, nor transmission, capacity to meet the load. Prices at the California Power Exchange (Cal PX) soared. Pacific Gas & Electric Company (PG&E) had to invoke rolling blackouts affecting some 100,000 customers—including some in the heart of Silicon Valley.

Worse yet, June 14 was not even a summer day. The *really* hot summer days in California usually occur much later, in August to October. Embarrassed officials at the PX and the ISO, the regulators, the independent generators, and distribution companies, are all doing their best to explain why getting through the summer months is going to be, shall we say, *difficult*.

The public doesn't understand how something like this can happen in a supposedly advanced economy state like California. Many hi tech companies in Silicon Valley, like Sun Microsystems, have decided that they can no longer rely on their traditional suppliers for reliable service. Those who need reliable power—and who doesn't—are building their own back-up generators. No price is too high to pay when you, and your customers, rely on 24/7 operations. This includes companies with routers, servers, remotely accessible databases, and APS (application service providers). The same goes for many dot.coms whose only means of livelihood is through the Web.

The capacity shortfall and high energy prices have resulted in unexpected developments in California and elsewhere. Many energy-intensive industries have learned that they can make a lot more money by shifting, reducing, or entirely shutting down their operations. Firms can earn more money by supplying *negative* load than producing widgets because the price of energy is so high during tight capacity periods. Aluminum smelters as far away as the state of Washington have shut down because it makes a lot more sense to transmit power to energy hungry California than to produce aluminum. Guess what? With over 6% of the world aluminum smelter capacity affected, aluminum prices are rising.

Officials at the California Energy Commission, the agency responsible for long-term adequacy of energy supply in the Golden State, are in an awkward position. They went to great lengths to explain that 26 new power plants with 16,000 MW of additional capacity have been approved, or are under review for approval. That would add a comfortable safety margin to the current non-existent reserve margin. But none of this is expected to come on line until next summer—at the earliest. Three plants already approved and under construction are expected to be completed next year, with another two in 2002. But the 3,700 MW capacity of these five units will not help the tight capacity situation this summer, nor next.

Meanwhile, California continues to attract some 600,000 new residents each year. Its peak demand is expected to exceed 50,000 by 2003. As is usually the case, things are likely to get a lot worse before they get any better.

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## Scenes from Sydney

Peter Davies helps Tony Owen and his wife celebrate their wedding anniversary.

On the dinner cruise: Paul Tempest and Michelle Foss.

Past Presidents Dennis O'Brien and Hoesung Lee with Carol Dahl.

## More Scenes from Sydney

Peter Davies recognizes Bob Bartles and Denzil Fiebig for the Sydney Programme.

The ice sculpture and the food vied for top billing.

Peter Davies presents Hoesung Lee with his Past President's award.

Guy Caruso and party enjoy the dinner cruise.

Mike Lynch, Perry Sioshansi and party enjoy the opening reception.

A hungry group aboard the dinner cruise.

## USGS Estimates (continued from page 25)

world's undiscovered natural gas resources reside in the Middle East and North Africa conjures familiar political and economic scenarios. However, the unexpectedly large volumes of oil and gas along the Atlantic margins of South America and Africa, combined with reduced estimates of hydrocarbons in North America, provide a basis for some interesting new twists in supply-demand scenarios.

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## IAEE Meeting At the Annual ASSA/AEA Conference

The International Association for Energy Economics will be having its 3<sup>rd</sup> Annual Session at the Allied Social Science Association in New Orleans, Louisiana, USA January 5 - 7, 2001. If you attend the ASSA meeting please register as a member of IAEE. With more members attending we will be able to increase the number of sessions. We hope to see you there.

Session Title:

### Current Issues in Energy Economics and Energy Modeling (Q4)

**Presiding:** *Carol Dahl*, Colorado School of Mines  
*Boris Cournede*, Ministry of Economy, Finance, and Industry, Paris, France—The Special Economics of Gas Deregulation on the European Continent

*Prakash Loungani*, International Monetary Fund—21<sup>st</sup> Century Oil Shocks: Will They Occur? Will They Matter? Will We Be Prepared?

*Prasad Rao*, The Pennsylvania State University—The Choice of Crude Oil Quality in Petroleum Refining

*Anne Epaulard* and *Stephane Gallon*, Ecole Nationale de la Statistique et de l'Administration Economique, Malakoff, France and Ministry of Economics, Finance and Industry, Paris, France—A Model of Competition Between Nuclear and Gas-Fired Plants Using Real Options Theory to Assess Nuclear Investment Value

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## Publications

**The Model Oil and Gas Company**, Michael R. Smith (2000). Price: £ 395 / US \$ 632. Contact: Financial Times Energy, Maple House, 149 Tottenham Court Road, London W1P 9LL, UK. Phone: 44-20-7896-2241. Fax: 44-20-7896-2121. Email: orders.energy@ft.com

**Arab Oil & Gas Directory 2000, (2000)**. Price: \$1,240. Contact: Arab Petroleum Research Center, 7, avenue Ingres, 75016 Paris. Phone: 33-1-45-24-33-10. Fax: 33-1-45-20-16-85. Email: aprc@arab-oil-gas.com URL: <http://www.arab-oil-gas.com>

**Economic Evaluation of Bids for Nuclear Power Plants**. Price 710 Austrian schillings. 224 pp., 21 figures. Contact: International Atomic Energy Agency, Sales & Promotion Unit, Division of Conference and Document Services, PO Box 100, Wagramer Strasse 5, A-1400 Vienna, Austria. Fax: 43-1-2600-29-302, Email: sales.publications@iaea.org

## Calendar

**4-8 September 2000, Negotiation and Documenting Petroleum Industry Transactions**. University of Dundee, Scotland, UK. Contact: Jacquie Hay, Marketing Assistant, Centre for Energy, Petroleum and Mineral Law & Policy, University of Dundee, DD1 4HN, United Kingdom. Email: cepmlp@dundee.ac.uk URL: [www.dundee.ac.uk/cepmlp](http://www.dundee.ac.uk/cepmlp)

**10-11 September 2000, Oil Prices and Investment Retreat**. Le Meridien Picadilly, London, England. Contact: Jonathan Neale. Phone: 44-2-7704-6241. Fax: 44-2-7704-8440. Email: jneale@thecwcgroup.com URL: [www.thecwcgroup.com](http://www.thecwcgroup.com)

**11-13 September 2000, 2nd Annual Africa Infrastructure 2000**. Crowne Plaza Hotel, South Africa. Contact: Global Pacific & Partners International, Houston: Phone: 281-597-9578, Fax: 281-597-9589. South Africa: Phone: 27-11-782-3189, Fax: 27-11-782-3188. Email: babette@global.co.za URL: [www.glopac.com](http://www.glopac.com)

**11-15 September 2000, Natural Gas Negotiations and Contracts**. University of Dundee, Scotland, UK. Contact: Jacquie Hay, Marketing Assistant, Centre for Energy, Petroleum and Mineral Law & Policy, University of Dundee, DD1 4HN, United Kingdom. Email: cepmlp@dundee.ac.uk URL: [www.dundee.ac.uk/cepmlp](http://www.dundee.ac.uk/cepmlp)

**11-15 September 2000, Hyforum 2000: The International Hydrogen Energy Forum 2000**. Munich, Germany. Contact: Mrs. Sandra Hoderlein or Mr. Wolf Rasch, EFO Energie Forum GmbH, Godesberger Allee 90, D-53175 Bonn, Germany. Phone: 49-228-95-95-6-0. Fax: 49-228-95-95-6-50. Email: hyforum2000@zukunftsenergien.de URL: [www.hyforum2000.de](http://www.hyforum2000.de)

**14-15 September 2000, World LNG Conference**. Meridien Waldorf Hotel, London, England. Contact: Jonathan Neale. Phone: 44-2-7704-6241. Fax: 44-2-7704-8440. Email: jneale@thecwcgroup.com URL: [www.thecwcgroup.com](http://www.thecwcgroup.com)

**17-22 September 2000, Natural Gas: The Commercial and Political Challenges (Training Course)**. The Four Pillars, Oxford, England. Contact: Margaret Coen, The Alphanatia Partnership, Rodwell House, 100 Middlesex Street, London E1 7HD, United Kingdom. Phone: 44-20-7650-1405. Fax: 44-20-7650-1401. Email: training@alphanatia.com URL: [www.alphanatia.com](http://www.alphanatia.com)

**17-23 September 2000, African Petroleum Management Institute/Upstream Leadership Program 2000**. Johannesburg, South Africa. Contact: Global Pacific & Partners International, Houston: Phone: 281-597-9578, Fax: 281-597-9589. South Africa: Phone: 27-11-782-3189, Fax: 27-11-782-3188. Email: babette@global.co.za URL: [www.glopac.com](http://www.glopac.com)

**18-22 September 2000, UK Oil and Gas Law**. Russack's Hotel, St Andrews, Fife, Scotland, UK. Contact: Jacquie Hay, Marketing Assistant, Centre for Energy, Petroleum and Mineral Law & Policy, University of Dundee, DD1 4HN, United Kingdom. Email: cepmlp@dundee.ac.uk URL: [www.dundee.ac.uk/cepmlp](http://www.dundee.ac.uk/cepmlp)

(continued on page 32)